NATIONAL MUSEUM OF HEALTH AND MEDICINE

Forensic Mystery Workshop

TEACHER'S GUIDE GRADES 6-8

ABOUT YOUR TOUR

You and your class will investigate the remains of an unknown service member using the tools of forensic anthropology and human identification. Your visit will consist of a brief introduction to forensic identification, followed by seven stations of hands-on activities in our Collections Gallery and Human Identification Exhibit.

TIME

45 minutes

GROUP SIZE

Minimum of 10 students, maximum of 30 student

AT THE CONCLUSION OF THIS WORKSHOP, STUDENTS SHOULD BE ABLE TO:

- Define the terms f**orensics, forensic anthropology** and **forensic pathology**.
- List at least four characteristics of the human body that can be used to create a biological profile.
- List the six lines of evidence used in identification of service members.
- List at least two scientific lines of evidence used to make a positive identification of a service member.
- List at least three organizations that help with the process of forensic identification of military service members.
- Work in collaborative teams to perform an investigation using problem-solving and critical-thinking skills.

SUGGESTED PRE-VISIT CLASSROOM ACTIVITIES

- Review *Visiting our Museum* and what students will do during the workshop.
- Discuss the different fields of forensics, such as anthropology, psychology, medical examiners, and entomology.
- Review the human skeleton and how people can be identified using only their bones.
- Research a news story involving forensic anthropology.
- Review the mathematical methods of converting centimeters to inches and inches to feet.
- Build a DNA molecule (see Appendix 1).
- Make a dental impression (see Appendix 2).

VOCABULARY

ALLOMETRY:
The correlation of the size of a bone to a person's height

BIOLOGICAL PROFILE:
The estimation of the skeleton's (or unidentified person's) age, sex, stature, ancestry and any signs of trauma or pathology

COMMINGLED:
Mixed

DECEDENT:
A general scientific term that refers to a deceased individual (a person that has died)

DNA:
Deoxyribonucleic acid that is found in cells and can be analyzed to aid in the identification of human remains

EPIPHYSES:
The rounded end of the long bone, where growth plates are located

ERUPTED:
Teeth that are exposed through the gum

FORENSIC ANTHROPOLOGY:
A field of science that analyzes the human skeleton to create biological profile

FORENSIC ODONTOLOGY:
The proper handling, examination and evaluation of dental evidence

MASS FATALITY INCIDENT:
An incident that has a high fatality count that local emergency personnel cannot handle on their own. Examples include Hurricane Katrina, airplane crashes, or September 11, 2001

MATERIAL EVIDENCE:
All non-living items associated/found with the remains of a person

MEDICO-LEGAL:
Pertaining to the legal aspects of practicing medicine

MINIMUM NUMBER OF INDIVIDUALS:
The total minimum number of individuals or people found among the remains or at a site

POPULATION:
The collection of people, or organisms of a particular species, living in a given geographic area

RETURN OF THE DEAD PROGRAM:
World War II program to recover, return and identify the remains of World War II soldiers

SEXUAL DIMORPHISM:
Differences between the sexes of the same species

SKELETAL DEGENERATION:
Natural deterioration of the skeleton

UNERUPTED:
Teeth that have not protruded through the gum line

APPENDIX 1: DNA MODEL ACTIVITY

OBJECTIVES

- To introduce students to DNA
- To review DNA structure and complementary base-pairing with a hands-on activity

MATERIALS

- Small colored gum drops or marshmallows
- Toothpicks
- Long sticks of licorice

OVERVIEW

DNA (deoxyribonucleic acid) is found in the chromosomes of all living things. Chromosomes, located in the nucleus of cells, contain genetic information in long sequences of DNA. DNA provides a set of instructions on how to build the proteins in every living organism, what proteins are needed to create the organism, and in which sequence amino acids are needed to build all of the different proteins required for the organism's growth. All DNA is composed of three parts: a five-carbon sugar called deoxyribose, a phosphate group, and a nitrogen-containing base (there are four potential bases called adenine, guanine, cytosine and thymine). Nucleotide chains are formed as the phosphate group of one nucleotide attaches to the sugar of the following nucleotide--adenine combines with thymine and guanine combines with cytosine. The structure of DNA is double helix, which looks like a ladder that has been twisted. The phosphate/sugar attachments make up the outside of the ladder, while the combination of bases and phosphate attachments cause the DNA to twist.

PROCEDURE

- Discuss the chemistry, shape and information about the DNA molecule. You may also want to discuss the history of DNA research and discovery. Then have the students construct their own DNA molecule from candy.
- Have the students choose 4 different colors of gum drops or marshmallows. These will represent the base pairs for the molecule.
- The licorice will represent the phosphate backbone of the molecule. Each student will need two pieces of licorice.
- The toothpicks will be used to hold the molecule together.
- Have the students create a legend by writing down which color gumdrop or marshmallow corresponds with the base pair (i.e. green=adenine, red=thymine and so on).
- Have the students create the base pairs and stick the gum drops on the toothpick. Do this for all of the base pairs. Explain to the students that the order of the pairs make up the information of the DNA.
- Finally have the students attach the pairs to the licorice backbone. Once all of the pairs are attached, slowly twist the molecule to form a double helix or what looks like a twisting ladder. Review the importance of the shape of the molecule. Have each student explain his/her nitrogen-containing base legend and define complementary base pairing to reinforce knowledge and understanding. Now they can enjoy the candy!

APPENDIX 2: DENTAL IMPRESSION ACTIVITY

OBJECTIVES

- This activity will allow students to match dental patterns with an individual.

MATERIALS

- Styrofoam plate or cups
- Pen(s)
- Scissors
- Data sheet

OVERVIEW

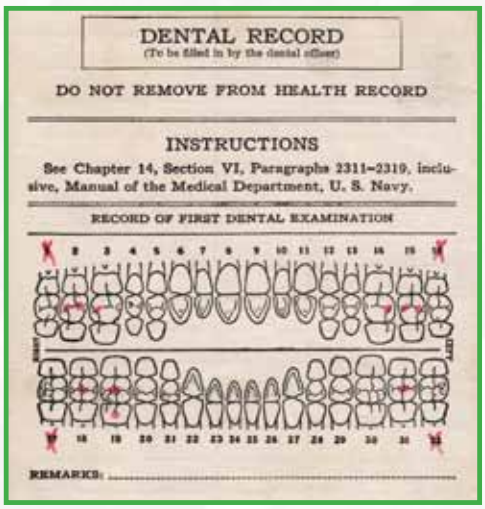
Odontology or forensic dentistry is the application of dentistry in a legal setting. The use of dentistry is an excellent method of identification of individuals, either alive or deceased. This is due to the fact that everyone's teeth and teeth patterns are unique. Most people have been to the dentist where their teeth have been recorded into an antemortem dental chart, which can be used for comparison in the future. Teeth can also withstand destruction, decay and extreme temperatures up to 1600 degrees F. As a result, teeth can be used as a better method of identification than fingerprints.

PREP

- Prior to the beginning of the class/activity, choose one student to be the victim. This person will need to make two dental impressions, one as an unknown individual and one as a known for comparison. Choose four to five other students in addition to the first for comparison that may be a possible victim.
- Have the students make their dental impression on the Styrofoam plate or cup and place these with their names on a paper plate on a table for future observation.

PROCEDURE

- At the beginning of the activity, discuss with the students the importance of dental charting, radiographs and how teeth are used for identification of individuals.
- Divide the students into groups or pairs and distribute one Styrofoam plate, pen and scissors to each group.
- Have the students cut the plate into "bite-sized" sections for the group to take their own dental impressions. The students should mark any unique characteristics with a pen and record their findings on a separate sheet of paper that can be their Data Sheet.
- Create a scenario in which an individual was recovered from a crime scene or site. Explain that we have dental impressions as the information on the individual. Have the students look at the impressions at the table and determine a match.
- Discuss the class' findings and observations. You may want to discuss the difficulty some odontologists have when there is not complete information on the individual for comparison.



DENTAL RECORD

(To be filled in by the dental officer)

DO NOT REMOVE FROM HEALTH RECORD

INSTRUCTIONS

See Chapter 14, Section VI, Paragraphs 2311–2319, inclusive, Manual of the Medical Department, U. S. Navy.

RECORD OF FIRST DENTAL EXAMINATION

REMARKS: .....

APPENDIX 3: DNA EXTRACTION ACTIVITY

OVERVIEW

During this activity, you will extract DNA from a strawberry or a kiwi. You will pulverize the fruit; mix it with a solution of water, dish detergent and salt; filter it into a test tube; add a layer of ethanol; and then stir the mixture so that it collects on a stick so that you can view the DNA.

Strawberries and kiwis work well in this activity because they are soft and easy to pulverize. Also, these ripe fruits produce pectinases and celluloses, which break down the cell walls. Most interestingly, these fruits have enormous genomes. They are octoploid, which means they have eight of each type of chromosome. Since there are so many chromosomes containing DNA, it is easy to extract and see the DNA with the naked eye. When you add liquid dish detergent to the pulverized fruit, it helps to dissolve the phospholipids bilayers of the cell membrane and organelles. The addition of salt helps to keep the proteins in the extract layer so they are not precipitated with the DNA. DNA is not soluble in ethanol—this means that when you mix ethanol with DNA molecules, they clump together and become visible. The colder the ethanol, the less soluble the DNA will be in it. This is why it is important for the ethanol to be kept in the freezer or in an ice bath.

This process is very similar to extracting DNA from ancient bones. The bone is placed in a blender until it becomes a powder; soap is added to the mixture and then alcohol. From this solution, technicians are able to extract and sequence DNA to be used during identification.

MATERIALS

- Ripe frozen or fresh strawberries or kiwis
- Buffer solution (Liquid dish soap, such as Dawn or Palmolive mixed with water and salt in a small test tube. Should be between 30-50ml of the buffer solution)
- 10 ml ethanol in a test tube, chilled on ice
- Plastic Ziploc bags
- Cheesecloth or a coffee filter (1-2 layers thick)
- Clear test tubes
- Wire or sticks
- Funnel
- Small beaker or cup

PROCEDURE

- Divide the students into small groups depending on class size. Dispense the following to each group: one Ziploc bag, one strawberry or kiwi, buffer solution, chilled ethanol, cheesecloth, funnel, beaker/cup and wire.
- Have the students place the fruit in the plastic bag and mash it until it is almost a liquid, this should take about 2 minutes.
- Add the buffer solution to the pulverized fruit and mix for 1 minute.
- Next, drain and filter the solution into the beaker/cup through the funnel covered with cheese cloth. This is the solution from which the DNA will be extracted.
- Pour this mixture into the clear test tube. Add the 10ml of chilled ethanol.
- The ethanol will sit on top of the fruit mixture and will cause the DNA to separate from the solution. After a few moments the students will be able to see a white cloudy layer form between the fruit buffer solution and the ethanol. This is the fruit DNA.
- Have the students spool the DNA on the wire or stick and extract it from the solution. It should look like a cloudy mucous. Have the students record the observations.

APPENDIX 4: FINGERPRINT ACTIVITIES

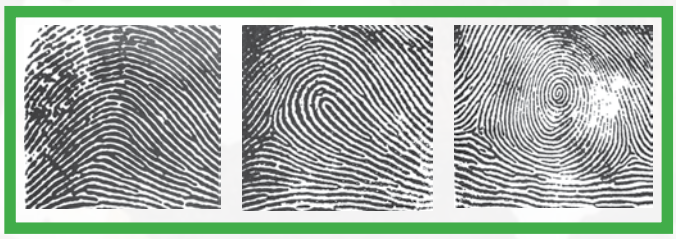
ACTIVITY #1: IDENTIFYING FINGERPRINTS

OVERVIEW

Fingerprints are an important tool in identification of individuals for both criminal and postmortem identification. Every person has unique fingerprints, based on three major types: arches, whorls and loops. FBI personnel have experts trained in analyzing fingerprints. They have collected over 8,000 references from government and military members and also aid local authorities in scenarios such as mass disasters. Fingerprints can be retrieved from a variety of surfaces such as glass, plastic, and deceased individuals. This activity will give students an opportunity to create and identify their own prints.

MATERIALS

- White paper
- Ink pads
- Wet wipes
- Fingerprint identification chart



ARCH LOOP WHIRL

PROCEDURE

- Begin the activity by reviewing the history of fingerprinting and the most common types of prints that are used to identify individuals.
- Have the students fold the white piece of paper in half and mark the columns with left and right hands. Also, make sure that the students have written their name on the document.
- Have the students take their prints and place them on the white paper. Make sure the students label each print with thumb, index finger, etc. The students will need to leave room on the sheet to identify the type of print.
- Next have the students trade prints with a partner or friend. Have the students identify the type of prints on the paper from the identification chart.
- Discuss the process and difficulty of identifying fingerprints. You may use these prints for future activities.

APPENDIX 4: FINGERPRINT ACTIVITIES

ACTIVITY #2: LATENT COCOA POWDER FINGERPRINTING

OVERVIEW

The oils, perspiration and amino acids on the skin allow for prints to be left on a variety of objects, especially those with hard surfaces. One method to retrieve prints from hard surfaces such as glass is to dust the area with a powder. Different powders are used on different colored surfaces to show the print in a contrasting color on the object. This activity will be using cocoa powder to retrieve prints on clear glass.

MATERIALS

- Cocoa powder
- Clear glass slides
- Clear tape
- Fingerprint identification chart
- Makeup blush brush
- Student fingerprint charts from previous activity or white piece of paper

PROCEDURE

- Begin by reviewing the different types of fingerprints and how fingerprints are left on objects.
- Have the students run their fingers over their nose or through their hair to retrieve extra oils on their fingers.
- Next, have the students make a print on the clear glass slide or object.
- Using the cocoa powder and the makeup brush, dust the glass slide for the print.
- Once you are able to see the print, take a piece of clear tape and place it over the print, slowly rubbing the tape down on the slide from one edge to the other. Slowly lift the tape from the slide and place the print on a white piece of paper or the student fingerprint charts.
- Finally, have the students identify and match the print with their own fingerprint chart. Discuss the process and difficulty of lifting prints for analysis.

APPENDIX 4: FINGERPRINT ACTIVITIES

ACTIVITY #3 LATENT CHEMICAL FIXING FINGERPRINTING

OVERVIEW

Another method to retrieve prints from hard objects is to use chemical fixing. Certain chemicals will react with the oils and amino acids from the skin visualize the latent or hidden the print. Ninhydrin creates a blue-purple color on the print when it reacts with amino acids, while silver nitrate reacts with the salt from the skin to create a reddish-brown print when seen under ultraviolet light. This activity will be using super glue fuming to show prints on a hard plastic or glass surface. This print will appear as an off-white shade.

MATERIALS

- Super glue
- Small pieces of metal or plastic
- Large jar with lid (one per group)

PROCEDURE

- Discus with the students the process and reasons for using chemical fixing to visualize fingerprints.
- Have the students split into small groups each with a piece of plastic or metal, large jar and super glue.
- Have the students make a fingerprint on the object and place it in the jar.
- Next place a few small drops of super glue next to the object in the jar, avoiding getting any glue on the object.
- Place the lid on the jar, do not inhale fumes and let the jar sit for 30 minutes.
- Following the 30 minutes or during the next class, students should be able to see their prints on the object. Have the students record and discuss their observations.

RESOURCES

The appearance of hyperlinks does not constitute endorsement by the NMHM or any other agency of the U.S. Government of the destination web site or the information, products or services contained therein.

WEBSITES

Office of the Armed Forces Medical Examiner, http://www.afmes.mil

Defense POW/MIA Accounting Agency, https://www.dpaa.mil

DNA Information, www.dnai.org

FBI: Federal Bureau of Investigation, http://www.fbi.gov

Written in Bone, http://writteninbone.si.edu

Visible Proofs: Forensic Views of the Body, http://www.nlm.nih.gov/visibleproofs/

PUBLICATIONS

***The Forensic Casebook: The Science of Crime Scene Investigation*, Ngaire E. Genge, 2002**

***The Bone Detectives: How Forensic Anthropologists Solve Crimes and Uncover Mysteries of the Dead*, Donna M. Jackson and Charlie Fellenbaum, 1996**

***Talking Bones: The Science of Forensic Anthropology* (Facts on File Science Sourcebooks), Peggy Thomas, 1995**

***Soldier Dead: How we recover, identify, bury and honor our military fallen*, Michael Sledge, 2007**

BIBLIOGRAPHY AND LINKS

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). Common Core State Standards. Retrieved from www.corestandards.org

National Research Council. (1996). National Science Education Standards. Washington, DC: The National Academies Press.

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press.

NGSS Lead States. (2013). Next Generation Science Standards: For States, By States. Retrieved from www.nextgenscience.org

Maryland State Department of Education. (2013). Maryland State Curriculum. Retrieved from http://mdk12.org/instruction/curriculum/

NATIONAL SCIENCE STANDARDS

- Use appropriate tools and techniques to gather, analyze and interpret data.
- Think critically and logically to make the relationships between evidence and explanations.
- Communicate scientific procedures and explanations.
- Use mathematics and computational thinking in all aspects of scientific inquiry.

COMMON CORE

- Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics. (RST.6-8.4)
- Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others' ideas and expressing their own clearly. (SL.8.1)
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations. (7.EE.B.3)